NEWELL (O.K.)

THE

IMPROVEMENT OF EVACUATORS

FOR LITHOLAPAXY

AND THE

LATER DEVELOPMENTS OF THE OPERATION

BY

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WHEN Professor Bigelow, in 1878, first taught the world the value of litholapaxy, by demonstrating the toleration of the bladder to prolonged operation, he furnished what has been the greatest incentive to the improvement of instruments for the modern stone operation.

Nothing appeals more strongly to the mechanical sense of surgeons and the acquirement of delicate manipulative power than the construction and use of stone-instruments; and its history is as interesting, perhaps, as any chapter of surgery. I shall but briefly consider the development of evacuators up to the point of what I believe to be the best type among those thus far produced. It does not seem reasonable that an instrument which first began to be constructed certainly no further back than 1834 should yet have reached perfection; nor is it probable that advantageous change will not continue to be made until evacuators are no longer needed.

The development of evacuators is familiar to all. It began with Crampton's bottle, which was but a common ovoid glass flask with a stop-cock at its neck allowing the air to be exhausted. This was attached to a catheter introduced into the bladder and, with the stop-cock opened, drew the urine, in which were crushed stone fragments, into its vacuum. There was, in this bottle, no trap. The lithérétie of Cornay was a similar arrangement, and, according to Ashhurst's "International Encyclopædia of Surgery," was described one year earlier than Crampton's bottle. In this instrument, also, there was no trap, and as but one suction or pumping movement was made at a time, none was needed. Then came, with Mercier's washing bottle, and Clover's first evacuator, the various rubber-bulbed instruments into which a trap was introduced to admit of repeated suction movements. Without describing or criticising in detail any of these instruments, or any of the subsequent evacuators, I shall endeavor to show that in all of them two important factors in construction have been overlooked. First, that a trap is an unnecessary element introduced into the length of the evacuating canal. Second, that the surgical distance from the external meatus to the bladder is rarely more than from four to six inches, and that therefore the length of the evacuating canal through which fragments are to be lifted should seldom exceed twelve inches, and may range, in children and adults, anywhere from six to twelve inches, this including the total distance which fragments have to travel. The value of these statements to the welfare of litholapaxy is great, for it is important to increase its scope and diminish its mortality by every possible improvement of the instruments concerned in its performance. This is especially true for cases of stone in children; and where in adults, from large size of stone or other complication, the operation may be prolonged for even two hours or more. Notwithstanding the suggestion from many able operators, of recurring under the advantage of antisepsis more frequently to lithotomy by the supra-pubic way, I cannot but think, in consideration of the beautiful results of litholapaxy in children, that a stone will rarely be found whose removal shall depend upon the use of the knife.

In discussing the improvement of evacuators, I shall consider in detail those parts which have been radically changed in my instrument, and begin with the trap, which, whether as a form of valve or special receiver, has entered into the construction of all the other modern instruments.

The Trap.—That in a properly constructed evacuator a trap complicating and increasing the length of the evacuating canal is unnecessary can perhaps be best demonstrated by using my evacuator (Fig. 9). In this evacuator, as may be seen, the radical change is the introduction of a shortened tube into the top of the bulb.

Fragments of coal, coral, and other materials have been used by former experimenters in demonstrating the action of their evacuators; and although I have used all these, in order to be still more certain I have chosen fine sand for the crucial test. Now, it will be seen in operating the evacuator, that the sand fragments are rapidly drawn in by the aspirations of the bulb, driven against its top, and thrown into the receiver. They do not tend to float nor to be carried about in any swirl of the current, but in accordance with physical laws sink rapidly, and will be even seen to do so during compression of the bulb. In fact, so absolutely does the receiver, and the greater part of the bulb, for that matter, represent what Professor Otis, in describing his "perfected evacuator," has termed a dead point, that the grains of sand will be seen to settle quietly in a pile, the conformation of which will not be in the least disturbed by the most forcible compression of the bulb.

At the top of the evacuator, as in my first model, is attached the Bigelow pipe for filling. This I consider one of the most valuable parts of an evacuator, for by its use the volume of fluid in the bulb and bladder may be at any instant rapidly increased or diminished, and all air removed from the apparatus.

Tubes.—My second point for consideration is the evacuating tube, and in its construction we should bear well in mind what I have endeavored to lay stress upon in two previous publications, and that is the fact that the surgical distance into the bladder is usually not more than from four to six inches. By this I mean, and I have repeatedly proved the fact upon the cadaver and in the living subject, that if we take an ordinary curved metallic sound, introduce it well into the bladder, depress it to a plane parallel with the table, and then withdraw it until the curve arrests its further progress, we will, by pushing the glans as far back as possible upon the external portion of the instrument, find if we hold it at this point and then withdraw it, that only a few inches, three and one-half to six at the most, have been engaged upon what I am pleased to call the surgical length of the urethra, or the surgical distance to the bladder. This can be well shown by studying a figure from a frozen section made by me through a split metallic sound introduced and fastened in the position just indicated. The difference between it and the usual figures illustrating this subject is readily seen.

It therefore seems that in the construction of evacuating tubes we should endeavor to have them made so as to apply to the most advantageous length possible of use in each case. Why should we maintain a uniformity in

the length of tubes any more than in their calibre? I have seen a large number of cases in adults where evacuation could have been readily performed through a six-inch tube, while in others, as we all know, the evacuating power of the bulb has had to be diminished by very long tubes in order to overcome the difficulties of a prostatic

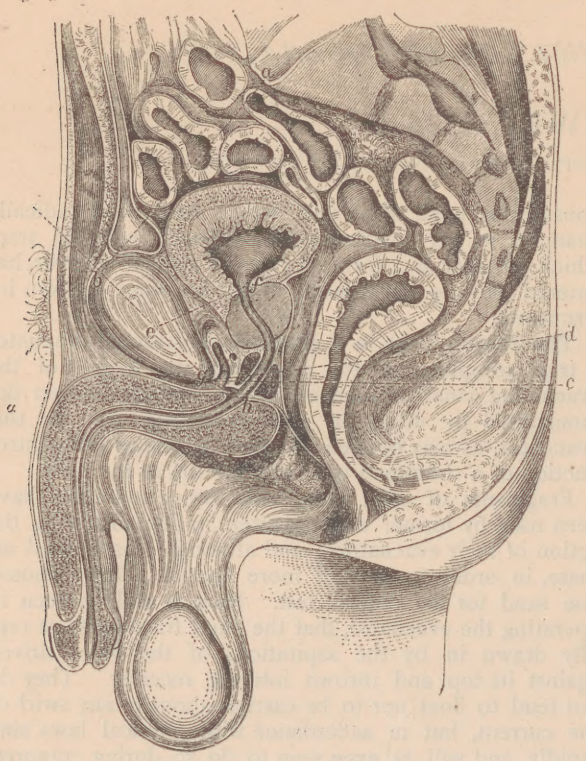

FIG. 1.—Taken from Dittel's Deutsche Chirurgie.

obstruction. In a delicate operation like litholapaxy, it does not seem wise to restrict ourselves to a limited and fixed set of tubes.

The more I become experienced in the use of straight open-ended tubes, the more I am convinced of their great superiority over any other kind. Given a bladder fully distensible and without inordinate prostatic obstruction, their action is perfect. One soon learns, using a tube that moves freely in the urethra, to place the tube orifice with the utmost precision and delicacy. By a few gentle aspirations the bladder wall can be felt almost as delicately as with the finger, and then the tube orifice placed in any desired position. Through these tubes the fragments travel in a straight line, and thus may be rapidly shot into the bulb. If the obliquely-cut opening be held laterally, the side of the tube may be then used to press against the bladder-floor. With the taper joints by means of which the tubes are connected in my apparatus, the orifice may be readily turned in any direction without uncoupling the apparatus. The floor of a distended bladder is not very easily aspirated, nor is the wall, for that matter, when the distention is even and full. With the orifice turned downward and held about one-fourth of an inch from the bladder-floor, the aspiration is very rapid. In fact, with the straight tube orifice carefully placed in any of the positions, lateral, upward, or downward, the aspiration is very rapid and certain. The fragments are shot in a straight line into the evacuator, and once there never return. I have had some operators, after using these tubes, say that after three or four aspirations there seemed to be something the matter, as no more fragments came. The fact, however, proved to be that they had all been removed, as the tubes were in the two cases in mind of 30 calibre. My straight tubes are constructed so that those of a given calibre take much larger fragments than can be passed through unguiform-tipped tubes of the same size. This is especially the case with those used in children, 17 F and lower calibre, where the advantage of the straight open-ended tubes is so great as to make the operation feasible with them, where it would otherwise not be. Where the straight open-ended tubes cannot be used I prefer a curved unguiform-tipped tube eight inches or more in length. This sort of a tube is needed in those extreme cases of prostatic enlargement which elevation of the pelvis will not overcome. Whether in children or adults, the fingers gently used in the rectum will enable one to locate the tube orifice, if necessary, with the utmost precision. Much to my surprise, at first, I found experimentally that a straight unguiform tipped tube acts really like a curved tube by drawing the fluid, not in the direction of its own long axis, but at an angle as indicated by the arrow in the figure. This must naturally be the case, since, as the tube is constructed, the orifice is really a hole in its side. This may be readily demonstrated by holding the tube orifice near the surface of water in a flask, and observing the angle taken by the vortex made by the aspiration. No matter if the tip be buried in the bladder floor then, the current tends to draw over fragments settled at the bottom, and not to draw them directly toward its orifice. This, in the last and critical portion of the aspiration where the fragments are diminished in number, is very important. If the bladder-wall is forcibly aspirated, it will be cut as easily by the sharp sides of the unguiform-tipped tube as by my oblique orifice, the edges of which are rounded. But, as will be stated further on, this is an accident which should be avoided. I am now having my tubes made of aluminium, and also stone-sounds of that metal.

In considering the method of procedure in litholapaxy

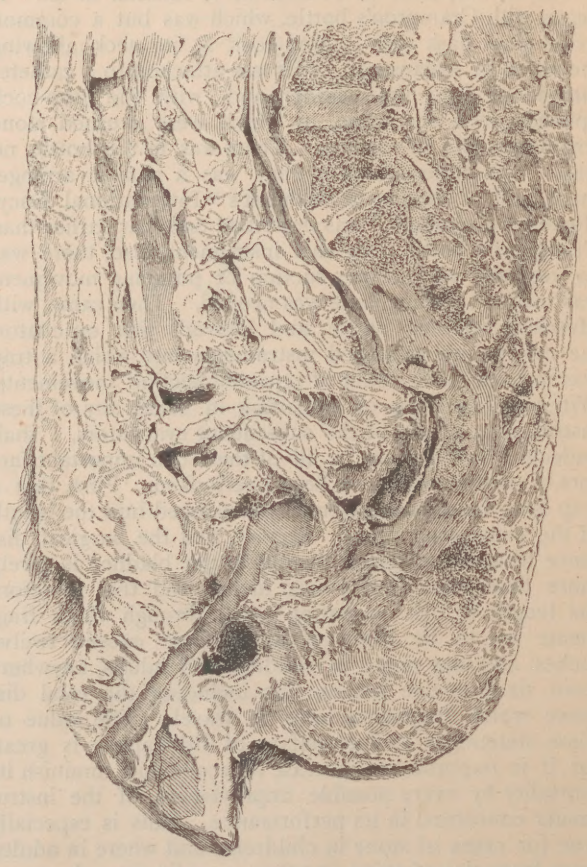

FIG. 2.—Frozen Section Made Through a Split Metallic Sound in Full-sized Adult, to Show Surgical Distance to Bladder.

to-day, there are, I think, many facts, deduced from the experience of various operators, which should be well borne in mind. In the first place this, like all other operations in the present time, must be made as much as possible an aseptic one; and although a preliminary treatment, as suggested in the "Vorbehandlung" recommended by some German authorities, is not needed, except in case

of stricture or urine with very unfavorable reaction, etc., yet at the time of the operation the bacteria should be reduced to a minimum. This is best accomplished by first scrubbing and washing the field of operation, and protecting it with antiseptic towels. Instruments should be taken apart, boiled in water where possible, or left for twenty minutes at least in five per cent. carbolic acid solution. For the disinfection of the bladder perhaps the most efficacious and practicable method is that of the greatest possible dilution of the bacteria, if not their complete removal, by thorough washing with the evacuator, using a two per cent. to five per cent. boracic acid, or a 1 to 5,000 or 10,000 corrosive sublimate solution. This should be done as a preliminary to all other steps in the operation, and the evacuator again disinfected. One very important point in the operation, both during crushing and evacuation, and one that is neglected by some operators in this country, although always advocated by such authorities as Ultzmann, Guyon, Thompson, Dittle, and others, is the elevation of the pelvis in adult males. This should be done, not as an exceptional expedient in the operation, but as the rule, by a pillow or specially made cushion placed beneath the buttocks. The prostate is thus usually eliminated from the field of operation, and fragments are more easily crushed and evacuated. The work with the lithotrite, in the average case, seems to be best done by holding the convexity of its female blade against the gently depressed wall of the bladder and steadily crushing fragments, as they are shaken into place by the ordinary slight movements of the instrument, and not by needless "fishing" about. The average stone is thus rapidly crushed and the operation uneventful, although of course any unusual formation of prostate or bladder may make every sort of tactics necessary in order to perform the operation.

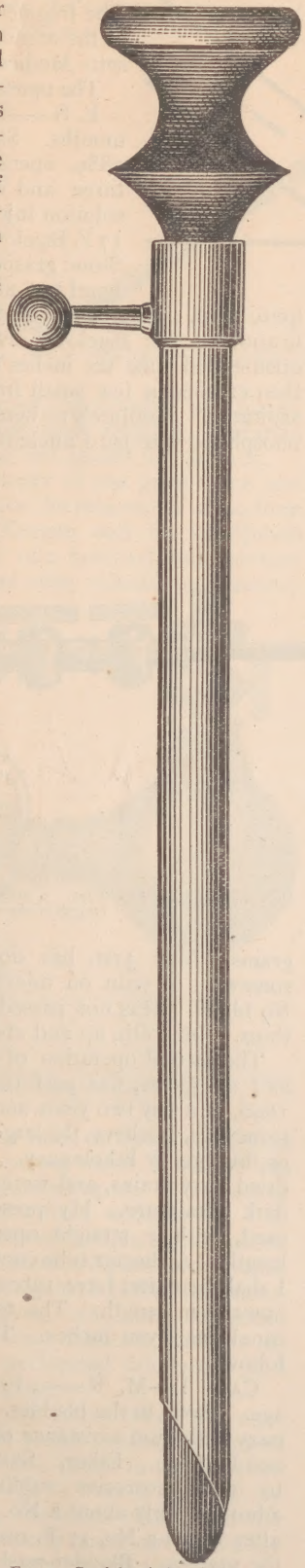

FIG. 3.—Straight, six-inch, Open-ended Tube, with Staff for Introduction. Slightly enlarged.

The operation of lithola-paxy should be a bloodless one. There is, I think, a strong tendency among many American operators to force the passage of unnecessarily large instruments. Only such should be used as pass with perfect freedom through the urethral canal, and thus admit of the greatest delicacy of manipulation, and assure the least disturbance of the parts. Instruments in the adult, therefore, varying in measurement from 25 to 30 F., and in children from 14 to 20 F., are the best. Comminution for passage through tubes of any of these sizes is readily enough accomplished. In the early use of large tubes it was naturally interesting to see of what size fragments could be delivered, but it is better for the welfare of the operation to limit them to the size of tubes as above indicated. By doing this we are not losing sight of the great advantage which Professor Otis' demonstration of urethral measurement has been to this operation, but taking intelligent advantage of it. Where the meatus requires division this may be done with the cautery, to avoid an open bleeding wound. Ultzmann has devised a special apparatus for this purpose.

In determining the quantity of fluid to be used for distention of the bladder, it is well to remember that as little as 150 c.c. have been known to cause rupture, and it is well to measure its capacity at first by careful injection. The bladder should always be distended, especially in evacuation, sufficiently to avoid aspiration or pinching of its wall. This sort of injury is the most common cause of hemorrhage, and can be well understood when one examines the delicate vascular wall of the bladder with the cystoscope. Very serious hemorrhage has thus been caused by injury to the venous plexus about the vesical neck, and Antal reports such a case examined by him afterward with the cystoscope. The injury was supposed to have been done with the lithotrite. I have often seen small clotted aggregations over points from which hemorrhage had come in bladders prone to bleed on cystoscopic examination.

Evacuation.—As far as the aspiration of fragments is concerned, I believe that here, as in crushing, the work is done at best advantage when the tube is placed with the orifice at the lowest depressable point of the bladder-wall. Here in time the current is sure to bring every fragment, and such as arrive during the lifting power of the bulb—that is, while there is still current enough to carry them to the inner end of the tube—are sure to be delivered into the receiver. The importance of the shortest possible canal is thus readily seen. If we take experimentally a glass tube four feet in length, we will find that with the expansion of the bulb the sand fragments will be drawn well up toward the top of the tube, but none of them will be carried over. If now we reduce the tube to one-half this length, we find that the fragments are thrown into the receiver in large quantities, and that those that fail to reach the inner orifice stop moving the instant the expansion of the bulb is completed, begin to fall backward, and are then driven out of the tube by the compression of the bulb. If the tube be now progressively shortened, we notice that the evacuating capacity of the apparatus is rapidly increased. The corollary is thus established that, as the length of the tube is diminished the working capacity of the evacuator is increased. The importance of using tubes of such calibre that, with free movement through the urethra the tactile sense is made most delicate, is very apparent.

Many may not realize how slight the lifting power of the ordinary bulb current is. According to the experiments of Desnos [1] it is capable of reaching still fragments at a distance of six to seven millimetres, while those set in motion by the bulb-current may be drawn in at a distance of from twelve to fifteen millimetres. The great advantage of increasing this power is readily seen. With a weak current we are apt to feel obliged at times to place the tube orifice too near the bladder-wall, and thus run the danger of wounding it. The shorter the tube, the longer the bulb expansion continues to draw fragments out of the bladder. To those who have not had much experience with this operation, or have made but little experimental study of it, the difficulty of evacuation and the amount of time it takes may be little realized. Professor Bigelow, in his original article on the subject, said: "Evacuation of fragments is quite an entertaining art, requiring as much skill to accomplish the result in the short-

[1] Antal: Pathologie und Therapie der Harnröhre und Harnblase.

est time as crushing them. Dexterity in the process will hardly be acquired without practice outside the bladder."

I cannot omit mentioning the great advantage which American operators have over those who do not use ether anæsthesia in this as well as other operations. I can

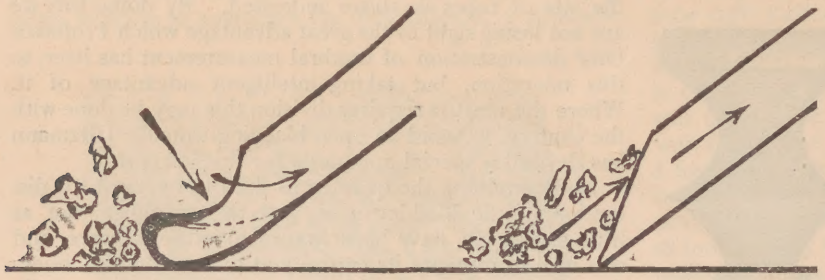

FIG. 4.

speak for the Massachusetts General Hospital at least, and for other clinics in this country as well, I think, and do not hesitate to say that we almost never have a case—and among thousands I have never seen one, even in those with heart lesions—where we have feared in the slightest degree to produce complete anæsthesia. In fact we have never had in our hospital, where ether was first introduced, a death directly attributable to it. This is in strong contrast with those cases where, as I have seen abroad, distention of the bladder has been abandoned because the muscular contractions could not be overcome, and there was fear of forcing the chloroform narcosis. Or, as shown in the following quotation from Antal, "Contra-indications: (*a*) such extreme sensibility of the bladder as cannot be sufficiently reduced by narcosis to admit of the performance of litholapaxy." Likewise, on page 15 of Mosetig-Moorhof's "Surgical Technique," in the chapter on anæsthesia, "As has before been mentioned, narcosis by means of sulphuric ether has now become wholly obsolete." Or from Ultzman, "Krankheiten der Harnblase," 1890, page 250: "In litholapaxy ether anæsthesia is generally insufficient." Sir Henry Thompson prefers ether for this operation.

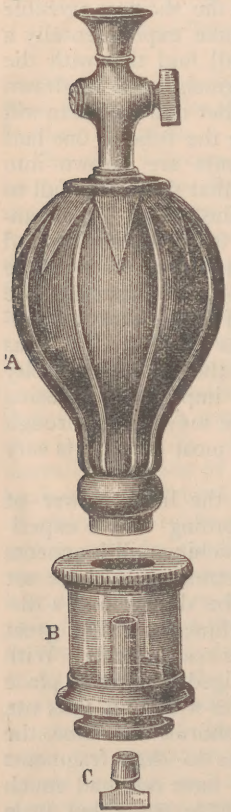

FIG. 5.—Ulzmann's Evacuator. ½ actual size. Very light, but practically like Clover's Evacuator. Length of evacuating canal, about 14 inches.

Cystoscopy.—For the diagnosis and general inspection of a case with stone in the bladder. the cystoscope is often of great value. I have in mind one remarkable case—that of a woman examined by me for Dr. John Homans—where most careful sounding had failed to reveal any stone; and yet with the cystoscope two small phosphatic calculi were easily seen, in the clear distention fluid, lying at the bottom of the bladder. Dr. Homans subsequently removed them by litholapaxy. Two other cases in men I have examined, where a small stone had not been detected by the sound. Both stones were removed by litholapaxy, one by Dr. C. B. Porter at the Massachusetts General Hospital, the other by myself in private practice. Any peculiar conformation of stone or bladder may be readily detected with the cystoscope.

Litholapaxy in Children.—The first American litholapaxy in a very young child was performed by Dr. H. H. A. Beach, at the Massachusetts General Hospital, on May 27, 1889. Dr. Beach was kind enough at that time to use my first model of evacuator, similar in principle to the present, and straight open-ended tubes. In fact, it is in great part owing to his never-failing kindness and co-operation that I have been enabled to accomplish what little I may have for this operation. A No. 17 F. Bigelow lithotrite, kindly loaned by Dr. Mixter from the Carney Hospital, was used for the crushing. The fragments of this stone were shown at the annual meeting of the Massachusetts Medical Society, in June, 1889.[1]

The operation was in detail as follows:

E. S——, aged three years and eight months. Stone in the bladder. May 27, 1889, operation by Dr. Beach. Ether, three and one-half ounces. Boracic solution injected into the bladder. No. 17 F. Bigelow lithotrite easily introduced. Stone grasped apparently the size of a hazel-nut and easily crushed, although quite hard. Fragments removed with Dr. Newell's modification of Dr. Bigelow's evacuator, and short straight open-ended tube six inches in length. With lithotrite then crushed a few small fragments which were readily aspirated. Absolutely no hemorrhage. Calculus stratified phosphatic with hard nucleus, weight twelve and one-half

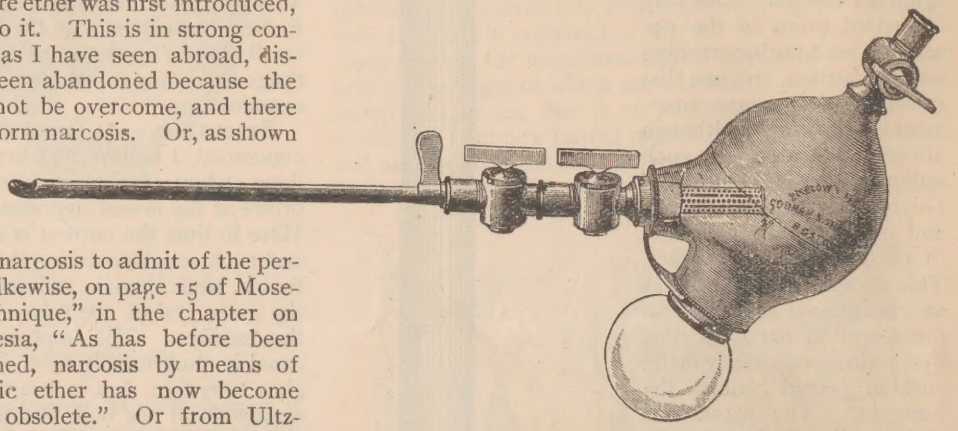

FIG. 6.—Bigelow's Evacuator. ¼ actual size. Weight, 24 ounces. Holds 10½ ounces. Length of evacuating canal, 15½ inches.

grains. May 31st, has done perfectly well, complains somewhat of pain on micturition. No œdema of glans. No blood. Has not passed any fragments. Slight diarrhœa. June 6th, up and about. June 12th, discharged.

The second operation of this kind in America, as far as I am aware, was performed by me on December 14, 1890, in a boy two years and eleven months of age. The stone was, I believe, the largest ever removed from a child of this age by litholapaxy. Its fragments weighed when dried sixty grains, and were phosphatic in character with dark admixture. My present model of evacuator was used, with a straight open-ended tube five inches in length. A shorter tube could have been readily used, and I shall hereafter have tubes made from four inches and upward in length. The total length of the evacuating canal was seven inches. The operation in detail was as follows:

CASE I.—M. R——, two years and eleven months of age. Stone in the bladder. December 14, 1890, litholapaxy with kind assistance of hospital externes Drs. Pease and Lothrop. Ether. Surrounding parts washed with 1 to 1,000 corrosive sublimate solution. The meatus admitted only about a No. 12 F. sound and was divided, after which a No. 17 F. readily entered the remainder of the urethra. Bladder washed with boracic solution, five per cent. Evacuator again disinfected. A No. 5 E. lithotrite, wholly fenestrated, made by Krohne & Sesemann, presented to me by my friend and colleague, Dr. John Homans 2d, was used and worked to perfection. I could readily have introduced a No. 17 F. Bigelow lithotrite which I had with me, but naturally preferred

[1] Boston Medical and Surgical Journal, vol. cxx., No. 25, p. 609.

the smaller instrument, as the stone was not very hard. The largest diameter of the stone seized in the lithotrite was about five-eighths of an inch. If it had not been for one fragment too large to pass through the 17 F. tube, there would have been but one crushing. As it was, I had to introduce the lithotrite a second time. The first fragment seized then, however, was the only one large enough to need crushing, and the operation with a second evacuation was rapidly accomplished. It lasted about fifty minutes, the crushings taking about fifteen and five minutes, respectively, the evacuation and other manœuvres the remainder of the time. The subsequent history of the case was, considerable pain with micturition for the first three days, but no fever and no bloody urine. The penis was somewhat swollen during this time. After the fourth day the patient remained comfortable and played about the room. Twenty-two days after the operation the boy was entirely well, and had gained five pounds.

There is no longer any doubt of the great value and superiority of this operation for the removal of stone from children. Established by Keegan and his coadjutors with the remarkable list of one hundred and fourteen cases, it has been sustained by many valuable supplementary lists. Among those next in value probably stands that of Freyer, thirty-four cases, among which I believe was the youngest child thus far operated upon. This patient was a child of eighteen months, from whom a No. 5 E. lithotrite and a No. 6 E. cannula removed, in eight minutes, a stone the dried fragments of which weighed three grains. Dr. D. P. Allen, of Cleveland, reported before the American Medical Association, in June, 1889, four admirable and successful cases. They were, however, patients already in their teens. I have performed litholapaxy successfully in a boy of eighteen years.

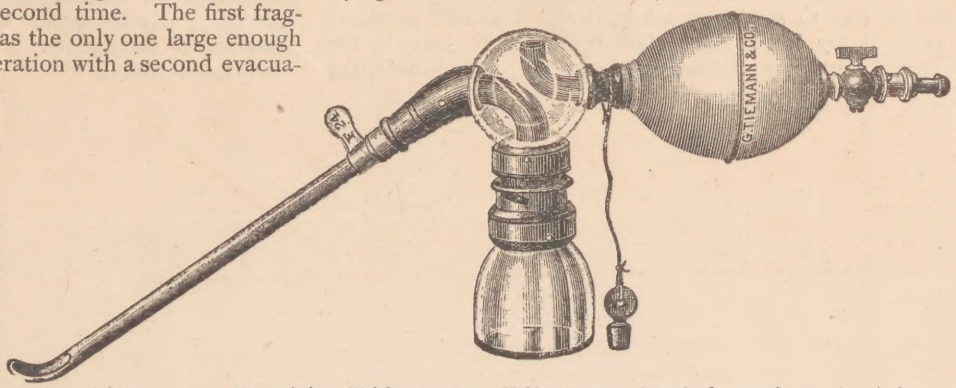

FIG. 8.—Otis's Evacuator. ¼ actual size. Weighs 10 ounces. Holds 8 ounces. Length of evacuating canal, 14 inches.

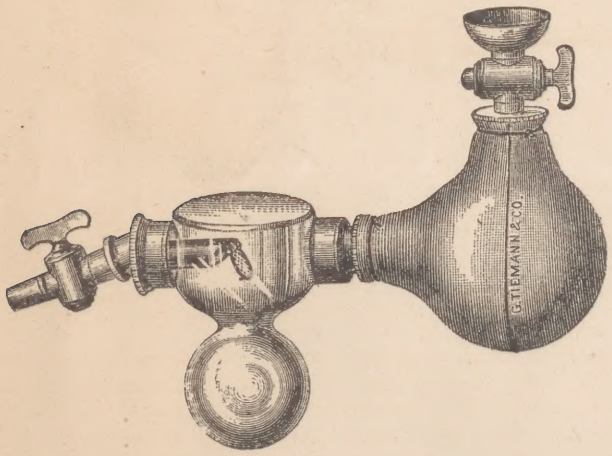

FIG. 7.—Thompson's Evacuator. ¼ actual size. Weight, 27¾ ounces. Holds 12½ ounces. Length of evacuating canal, probably 14 inches.

As far as this operation in very young children is concerned, I believe, so admirable are its results, that where there are no contra-indications it is better to let the stone remain until the child is of an age to have it removed by litholapaxy. This, by keeping the urine dilute and the child well nourished and moderately quiet, can be readily done. My patient's condition was much improved by adopting this plan for three months preceding the operation. This I did, not on account of the urethral calibre, but with regard to the poor physical condition. The child improved greatly during these three months, and was in fine condition at the time of the operation. By following this plan we should avoid the mutilation of lithotomy, which, with its various sequelæ, stricture, prostatic obstruction, residual urine, cystitis, etc., may, as was said by some old French authority, I believe, be the death-mark of him who receives it. How often we see children who with no great discomfort have carried stone, as far as symptoms could indicate, for years!

The tabulated cases, as far as I have been able to find them in the "Index Medicus" and elsewhere, are as follows:

Litholapaxy in Children.

Operator.	Number of cases.	Recovered.	Died.	Country.
Keegan	114	110	..	India.
Freyer	34	34	..	"
Marshall	5	5	..	England.
Beach	1	1	..	America.
Newell	1	1	..	"

It was my good fortune to be the recipient of a double term as house officer at the Massachusetts General Hospital under Professor Bigelow's direction, which gave me, instead of the customary single service, an opportunity during two years to work with him soon after the publication of his earliest papers upon the new operation. I remember well his great enthusiasm upon the subject, and his unbounded devotion to his patients. One could not work with him continuously without being impressed with the importance of developing every mechanical possibility that would reduce difficulties and make his great discovery practicable for all. No one urged this point more than he in the critical remarks with which he accompanied his operations. A few months before his death I called to show him my proposed changes in evacuators, feeling sure of his kind interest in any instrumental improvement that was likely to facilitate his operation. He expressed much interest in my new model, which I was to exhibit before the Suffolk District Surgical Section of our State Medical Society, and asked me to state there for him that

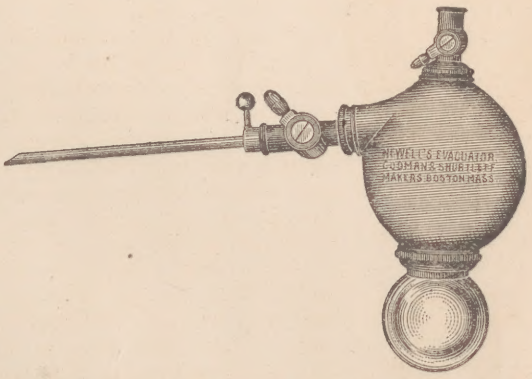

FIG. 9.—Newell's Evacuator. ¼ actual size. Weighs 9¾ ounces; holds 9¾ ounces; length of evacuating canal, as used in children and adults, 6 to 10 inches. Special advantages may be considered to be, 1, its simplicity, being without trap and with shortest evacuating canal thus far made possible; 2, its lightness; 3, taper joints to admit of readily turning the tube orifice in any direction without uncoupling; 4, form of stop-cock, which may be readily operated with a single finger; 5, aluminium tubes; 6, non-corrodable, being made of rubber and glass.

he had hoped to overcome the problem of weight in the future by the use of aluminium fittings, promising if able to attend the meeting. At the close of a most delightful interview he said, "Well, Newell, I've no doubt that you have got a good evacuator, and after all, a thing is bound in the end to stand on its merits." This had certainly been shown but a short time before in his case, by the most courteous acknowledgment of his litholapaxy published in the London *Lancet* by Sir Henry Thompson.

In conclusion, if I have contributed anything to make Dr. Bigelow's operation easier of execution and more practicable for the general operator, it is the tribute that I desire to pay the genius that illuminated the surgery of America for forty years.

68 St. James Avenue.